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The USE *and* DESCRIPTION *of a* NEW-INVENTED INSTRUMENT *for* NAVIGATION, *by which every Caſe in plane, middle Latitude or Mercator's Sailing may be performed without Logarithms, Tables, or any numerical Calculations whatſoever.* *By* JOHN COOKE, *Eſq; M. R. I. A.*

Read Nov. 7, 1789.

THE object of this inſtrument is to facilitate the art of navigation, by reſolving mechanically every problem neceſſary in ſailing.

It is compoſed of a baſe, a perpendicular, a ſemicircle, and an index; which are ſo connected by ſlides, as to be capable of being moved into every neceſſary poſition. The ſemicircle contains the degrees of the circle, and alſo the points of the compaſs, for the purpoſe of laying off the courſe; the index, perpendicular and outſide edge of the baſe repreſent the diſtance, departure and proper latitude reſpectively; they are equally graduated, and each diviſion ſtands for a mile. There is alſo another line on the baſe, repreſenting the meridional parts; it is engraved on a cylinder contained within a groove in the baſe, and any part of this line neceſſary may be eaſily had by revolving the cylinder until it appears through the aperture prepared for that purpoſe.

THE method of working every caſe which occurs in navigation is to make the inſtrument ſimilar to that ideal triangle which is compoſed of the difference of latitude, departure and diſtance ſailed; or to that compoſed of the meridional difference of latitude, difference of longitude, and enlarged diſtance; or to that compoſed of the difference of longitude, departure, and ſine of the middle latitude, which is done by means of the data procured from the compaſs, log-line and quadrant; whence it follows, from the nature of ſimilar triangles, or from the relation which exiſts between the ſides, triangles, and the ſines of their oppoſite angles, that the parts of the inſtrument become proportional to theſe which they repreſent, and will aſcertain the length of the lines, or the extent of the angles ſought, by its graduations.

To make this general rule more eaſily underſtood, it is here particularly applied to each of the caſes of navigation.

CASE I.

THE latitudes and longitudes of two places given, to find the direct courſe and diſtance between them.

REQUIRED the courſe and diſtance between
Lat. 50° 50′ N. Long. 19° 00′ W. and
Lat. 54° 30′ N. Long. 15° 30′ W.

THE rule on the principles of Mercator's ſailing is,

MOVE the center of the ſemicircle perpendicularly over the meridional degree correſponding with the latitude departed from, 50° 50′ N. (by means of a ſquare) then move the box until the edge of the perpendicular cuts the meridional parts of the latitude in 54° 30′ N. and move the index until it cuts the difference of longitude 3° 30′ on the perpendicular, and the index will mark the courſe 30° 10′ or N. N. E. $\frac{3}{4}$ E. nearly on the ſemicircle.

To find the diſtance ſailed ſcrew the index to this courſe, and move the center of the ſemicircle to the proper latitude ſailed from, 50° 50′ N. and the edge of the perpendicular to the proper latitude arrived at, 54° 30′ N. and then the perpendicular will cut the diſtance 254$\frac{7}{10}$ miles on the index.

IT is performed on the principles of middle latitude ſailing, thus:

HALF the ſum of both latitudes taken from 90° is the complement of the middle latitude 37° 20′, and the leſſer longitude ſubtracted from the greater leaves the difference of longitude 3° 30′, or 210 miles.

MOVE the center of the ſemicircle to the proper latitude departed from 50° 50′ N. and the edge of the index to the complement of the middle latitude 37° 20′ on the ſemicircle, then move the box until the edge of the perpendicular interſects the termination of the difference of longitude 210 miles on the index, which point of interſection will mark the departure 128 on the perpendicular, then move the edge of the perpendicular to the proper latitude arrived at, 54° 30′, and the index until it cuts the departure 128 on the perpendicular, then will the perpendicular mark the diſtance on the index 254$\frac{7}{10}$ miles, and the index will mark the courſe on the ſemicircle 30° 10′, or N. N. E. $\frac{3}{4}$ E. nearly.

CASE II.

BOTH latitudes and courſe given, to find the diſtance and difference of longitude.

Lat. 50° 50′ N. Long. 19° 00′ W. ſailed from,
Lat. 54° 30′ N. arrived at; courſe N. 30° 10′ E.

By

By Mercator's ſailing.

Move the box and ſemicircle as in the former caſe to the meridional parts of the given latitudes, then ſet the index to the courſe, and it will mark the difference of longitude 3° 30′ on the perpendicular 15° 30′ W.

Then to find the diſtance move the perpendicular and ſemicircle to the proper latitudes given, and the perpendicular will cut the diſtance $254\frac{7}{10}$ miles on the index.

By middle Latitude ſailing.

Complement of the middle Lat. 37° 20′.

Move the ſemicircle and perpendicular to the latitudes given, and the index to the courſe, then the perpendicular will ſhow the departure 128 miles, and the index the diſtance $254\frac{7}{10}$ miles, at the point of interſection.

To find the difference of longitude ſet the index to the complement of the middle latitude on the ſemicircle, and move the box until the termination of the departure on the perpendicular meets the index, which will mark the difference of longitude thereon 210 miles, or 3° 30′.

CASE

CASE III.

Both latitudes and diſtance given, to find the courſe and difference of longitude.

Lat. 50° 50′ N. Long. 19° 00′ W. ſailed from,
Lat. 54° 30′ N. arrived at, diſtance ſailed 254$\frac{7}{10}$ miles.

Move the perpendicular and ſemicircle to the proper latitudes given, and the index until the diſtance ſailed marked on it meets the perpendicular, then the index will mark the courſe N. 30° 10′ E. on the ſemicircle.

To find the difference of longitude, ſcrew faſt the index to this courſe, move perpendicular and ſemicircle to the meridional parts of the given latitudes, and the ſpace intercepted between the limb of the box and the index will ſhow the difference of longitude 3° 30′.

By middle Latitude ſailing.

Complement of middle Lat. 37° 20.

Move the ſemicircle and perpendicular to the given latitudes, and the index until the diſtance ſailed marked on it cuts the perpendicular, then the perpendicular will ſhow the departure 128 miles, and the ſemicircle the courſe N. 30° 10′ E.

To find the difference of longitude, ſet the index to the complement of the middle latitude on the ſemicircle, and move the perpendicular until the termination of the departure on it cuts the index, then the point of interſection will mark the difference of longitude 210 miles on the index.

CASE IV.

BOTH latitudes and departure from the meridian given, to find the courſe, diſtance and difference of longitude.

Lat. 56° 40′ S. Long. 28° 55′ E. ſailed from.
Lat. 61° 20′ S. arrived at; departure 172 miles.

By Mercator's ſailing.

N. B. In ſailing through ſouthern latitudes, the end of the cylinder where the numbers begin muſt be turned towards the north, pointed out by the ſemicircle; and in ſailing through northern latitudes, it muſt be reverſed.

Rule.—Move the perpendicular and ſemicircle to the proper latitudes given, and lay the departure on the perpendicular, then move the index until it meets the point in which the departure terminates, the diſtance will be marked on the index 329, and the courſe S. 31° 35′ E. or S. S. E. $\frac{3}{4}$ E. nearly, on the ſemicircle.

To find the difference of longitude, move the perpendicular and ſemicircle to the meridional parts of the given latitudes, and the index will cut the difference of longitude on the perpendicular, 5° 35′.

By middle Latitude ſailing.

Complement of middle latitude 31° 00′.

Move the ſemicircle and perpendicular to the given latitudes, and the index to the termination of the departure marked on the perpendicular, the interſection will ſhow the diſtance 329 on the index, and the index the courſe on the ſemicircle, S. 31° 35′ E.

To find the difference of longitude, ſet the index to the complement of the middle latitude on the ſemicircle, and move the perpendicular until the departure marked on it cuts the index, and this point of interſection will mark the difference of longitude on the index 335 miles, or 5° 35′.

CASE V.

One latitude, courſe and diſtance given, to find the difference of latitude and difference of longitude.

Lat. 56° 40′ S. Long. 28° 55′ ſailed from.
Courſe S. 31° 35′ E.; diſtance ſailed 329 miles.

By

By Mercator's ſailing.

SET the ſemicircle to the proper latitude ſailed from, and the index to the courſe; mark the diſtance on it, and bring the perpendicular to the diſtance ſailed, which at the ſame time will mark the latitude arrived at on the line of proper latitude 61° 20′ S.; ſcrew the index to the courſe, and move the ſemicircle and perpendicular to the meridional parts of both latitudes, then the index will cut the difference of longitude on the perpendicular 5° 35′.

By middle Latitude ſailing.

FIND the latitude arrived at as above, and then find the difference of longitude as found by middle latitude ſailing in the preceding caſe.

CASE VI.

ONE latitude, courſe and departure given, to find the diſtance, difference of latitude, and difference of longitude.

Lat. 56° 40′ N. Long. 28° 55′ W.
Courſe N. 31° 35′ W.; departure 172.7 miles.

By Mercator's ſailing.

MOVE the ſemicircle to the proper latitude ſailed from, and the index to the courſe. Mark the departure on the perpendicular, and move it until the termination thereof meets the index, then the point of interſection will ſhow the diſtance 329 on the index, and the perpendicular will ſhow the latitude arrived at 61° 20′ N. on the baſe.

THEN ſcrew faſt the index, and move the perpendicular and ſemicircle to the meridional parts correſponding with both latitudes, then the index will cut the difference of longitude, 5° 35′ on the perpendicular.

By middle Latitude ſailing.

FIND the latitude arrived at and the diſtance as above, and the difference of longitude as in caſe IV. by middle latitude ſailing.

CASE VII.

ONE latitude, diſtance ſailed and the departure given, to find the courſe, difference of latitude, and difference of longitude.

Lat. 48° 30 N. Long. 14° 40′ W. ſailed from.
Diſtance ſouth eaſterly 345 miles, and departure 200 miles.

MOVE the ſemicircle to the latitude departed from, mark the diſtance on the index and the departure on the perpendicular, move both until theſe points meet, then will the index ſhew the courſe S. 35° 26′ E. on the ſemicircle, and the perpendicular the latitude arrived at 43° 49′ on the baſe.

THE

The difference of longitude is found as in the preceding caſe.

By middle Latitude ſailing.

The courſe and latitude arrived at are found as above, and the difference of longitude as in caſe IV. by middle latitude ſailing.

CASE VIII.

One latitude, courſe and difference of longitude given, to find the diſtance and difference of latitude.

Lat. 48° 30′ N. Long. 14° 40′ W. ſailed from.
Long. 9° 50′ arrived at; courſe S. 35° 26′ E.

By Mercator's ſailing.

Move the ſemicircle over the meridional parts of the latitude ſailed from, and the index to the courſe, and move the perpendicular until the difference of longitude marked on it meets the index, then the perpendicular will cut the meridional parts on the cylinder, which correſpond with the latitude arrived at, then bring the perpendicular and ſemicircle to the proper latitudes, and the diſtance 345 will be marked on the index by the perpendicular.

N. B. This caſe cannot be performed by middle latitude ſailing; and in ſailing on a parallel, or when there is no difference of latitude made, the longitude cannot be had by Mercator's ſailing, which makes it neceſſary to ſubjoin the two following caſes.

CASE IX.

THE difference of longitude between two places in one parallel of latitude given, to find the diſtance between them.

Lat. 49° 30′ N.
Difference of Long. 3° 30′ E.

RULE.

SET the index to the complement of the latitude, 40° 30′, on the ſemicircle, mark the difference of longitude in miles on the index, then move the perpendicular until it meets the termination of the difference of longitude on the index, and the part of the perpendicular intercepted between the limb of the box and the point of interſection will repreſent the diſtance 136.4 miles required.

CASE X.

THE diſtance between two places in one parallel of latitude given, to find the difference of longitude between them.

Lat. of the given parallel 49° 30′ N.
Diſtance ſailed E. 136.4.

RULE.

RULE.

SET the index to the complement of the latitude 40° 30′, and mark the diſtance ſailed on the perpendicular, and move it until it meets the index, then the point of interſection will ſhow the difference of longitude 210 miles, or 3° 30′ on the index.

IF it ſhould happen that the meridional parts of the given latitudes (36° and 44° N. lat.) are not contained on the ſame line of the cylinder, but begin upon one and terminate on another, then this difficulty is removed by ſliding the cylinder until the meridional degree of the latitude in 36° 00′ is brought near the extremity of the baſe, fixing the ſemicircle perpendicularly over it, and moving the edge of the perpendicular to the termination of the graduations on the cylinder, then turn the cylinder until the continuation of the line required appears, and place the beginning of it to the edge of the perpendicular where the former part of the line terminated, and move the perpendicular until it cuts the degree required, and the ſpace intercepted between it and the ſemicircle will be the meridional difference of latitude ſought.

The Method of working a Traverſe.

Lat. 46° 48′ N. Long. 7° 47′ W. ſailed from,

Courſes.	*Diſtances.*
S. S. W. ½ W. - -	24 miles
S. b W. - - -	36
S. ½ E. - - -	40

required the latitude and longitude arrived at, together with the direct courſe and diſtance.

SET the ſemicircle to the proper latitude departed from 46° 48′, and the index to the courſe S. S. W. ½ W.; mark the diſtance 24 on the index, and bring the perpendicular to meet it, then the index will cut the departure 11.3 on the perpendicular, and the perpendicular will cut the latitude 46° 27′ N. on the baſe. For the next caſe, bring the ſemicircle to the latitude marked by the perpendicular 46° 27′, and lay down the courſe S. b W.; if it be towards the firſt meridian, move the laſt marked departure until it meets the index, and the limb of the box will mark the preſent departure; but if the courſe be from the firſt meridian, bring the laſt departure 11.3 to the limb of the box, and the index will mark the departure made good 18.3 on the perpendicular, and the latitude arrived at 45° 52′ will be marked on the baſe by the perpendicular; proceed in the ſame manner with all the caſes of which the traverſe conſiſts, then the difference of latitude 11° 36′ will be intercepted between the latitude ſailed from 46° 48′ and the latitude

tude arrived at 45° 12′ laſt marked by the perpendicular, and alſo the departure made good will be intercepted between that point on the perpendicular where the firſt departure commenced, and that where the laſt terminated, then the courſe S. 8° 30′ W. the diſtance 97, and the longitude arrived at 8° 8′ are found as in caſe IV.

The Methods of correcting Dead Reckoning.

CASE I.

IF the courſe found by dead reckoning be leſs than three points or 33°.

Lat. by obſervation departed from - -	39° 18′ N.
Lat. by obſervation arrived at - -	37° 48′ N.
Lat. by dead reckoning arrived at - -	37° 31′ N.

Courſe by dead reckoning S. S. W. ¾ W.
Departure 64 weſterly.

Required the true difference of longitude?

RULE.

WITH the courſe S. S. W. ¾ W. and latitudes by obſervation 39° 18′ and 37° 48′, find the difference of longitude 1° 9′ by caſe II. of Mercator's or middle latitude ſailing.

CASE

CASE II.

If the courſe found by dead reckoning be more than three points or 33°, and leſs than five points or 56°.

Lat. by obſervation departed from - - 52° 40′ N.
Lat. by obſervation arrived at - - 54° 22′ N.
Lat. by account - - - - - - 54° 04′
Departure weſterly 76 miles.
Required the true difference of longitude?

RULE.

With the latitude by obſervation 39° 18′, and latitude by account arrived at 37° 31′, and the departure 64, find the diſtance 113 by caſe IV. of Mercator's ſailing, and with this diſtance and latitudes by obſervation find a ſecond departure 47.7 by caſe III. of Mercator's ſailing, and with half the ſum of theſe departures 61.8 and the latitudes by obſervation, find the true difference of longitude 1° 43′ by caſe IV. of Mercator's ſailing.

CASE III.

If the courſe by dead reckoning be more than five points or 56°.

Lat. by obſervation departed from - - 38° 52′ N.
Lat. by obſervation arrived at - - 40° 18′ N.
Lat. by account - - - - - - 40° — N.
Departure weſterly by account 112 miles.
Required the true difference of longitude?

RULE.

RULE.

With the latitude by obſervation departed from 38° 52′, and that by account arrived at 40° —′, and the departure 112, find the diſtance as above 113, and with this diſtance and the latitudes by obſervation, find the true difference of longitude 2° 10′ by Caſe III. of Mercator's ſailing.

The advantages expected to ariſe from the uſe of this inſtrument are, firſt, that no conſiderable miſtake can exiſt in the work, as the errors become obvious in proportion to their magnitude; whereas in calculations, miſplacing a ſingle figure will produce an error of the greateſt conſequence. Secondly, this method does not reſt on tables or logarithms, which abound in errors of the preſs even in the beſt editions, and are often the ſource of much confuſion. Thirdly, it will render the art of keeping a ſhip's reckoning eaſily learned, and eaſily practiſed. Many maſters of ſhips are perſons who have been raiſed to that office from the loweſt degree of ſeamen, who from want of capacity, or want of early opportunities, have acquired only a very ſuperficial knowledge of navigation; many who have been better educated diſqualify themſelves by their riotous and diſſolute lives for the practice of this intricate branch of ſcience. The accidents of the ſea, and other emergencies, frequently render it neceſſary to commit the care of a ſhip to an ignorant ſailor. In all which caſes the methods of calculating a ſhip's courſe now in uſe can not be adopted or relied on with ſafety, and therefore they generally have recourſe to the following dangerous alternatives:

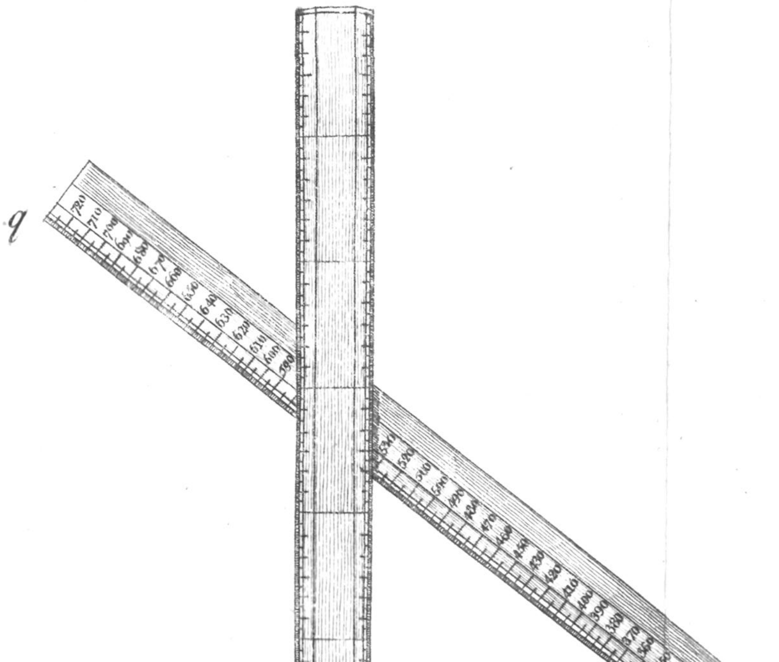
In coaſting and in ſhort voyages they ſail by day, when they may ſee the land, ſhould they approach it, and *lie to* at night.

In longer voyages they get into the latitude of the port ſailed to by the aſſiſtance of their quadrants, and then ſail eaſt or weſt *(which they term running down their longitude)* until they *ſtumble* as it were on their object.

Every day's experience furniſhes inſtances of the melancholy effects of theſe contrivances; and ſhould this ſcheme on enquiry be found capable of aſſiſting thoſe who are ignorant of better methods, it is humbly expected that the Academy will give their advice and countenance, as far as may be neceſſary, to bring it to maturity, and render it uſeful to ſociety.

EXPLANATION of the PLATE.

THE ſtock *a b c d* is a parallelopepid: The length from *a* to *b* is two feet, the breadth from *a* to *d* two inches, and the depth is one inch and half. This ſtock is perforated longitudinally, ſo as to be capable of containing within it *e f*, a cylindrical piece of timber one inch diameter. *g h* is an aperture on the ſurface of the ſtock, about a quarter of an inch wide, which diſcloſes one-twelfth part of the ſurface of the cylinder contained; the edge *d c* is divided into twelve parts, each of theſe are ſubdivided into ſix parts, and each of theſe are again ſubdivided into ten parts. The ſurface of the cylinder is divided longitudinally into twelve parts, and on each of them is engraved a portion of a line of meridional parts twenty-two feet long, which contains the meridional parts for every minute from the equator as far towards the pole as ſailing is practicable, and the ſmalleſt diviſion on it is not leſs than $\frac{1}{20}$th of an inch. By rolling and ſliding this cylinder any part of any line on it may be brought into any poſition which may be required; the box *i* is engrooved into the edge of the ſtock *a b*, ſo that it may move freely from *a* to *b*; a limb from this box extends to *k*, which ſerves to mark that degree of the perpendicular *i l*, which is parallel to the center of the ſemicircle *m*; *i l* is two feet long, and graduated on both edges as the ſtock; it is perpendicular to the ſtock, and is fixed in the box *i*, by which it may be moved from *a* to *b*. *o p n* is a ſemicircle of ſix inches radius, engraved as appears in the plate, which ſlides freely from *c* to *d* in a groove in the edge of the ſtock *c d*: *m q* is the index moving on the center *m*, the edge of which marks the courſe on the ſemicircle; it is two feet long, and divided into ſeventy-two parts, each of which are ſubdivided into ten parts, and are equal to the ſubdiviſions of the lines on the ſtock and perpendicular: *r* is a nonius attached to the index to ſhew the minutes of the angle of the courſe *q m o*. *S* is a nonius compoſed of concentric ſemicircles, which ſlides along the edge *q m*, to the interſection of the perpendicular and index, where it ſerves as a nonius to both; below *x* is a ſmall piece of ivory, with a mark on it to point out the degree of the line *d c*, which is perpendicularly under the center of the ſemicircle. *t* is a view of the back part of the inſtrument.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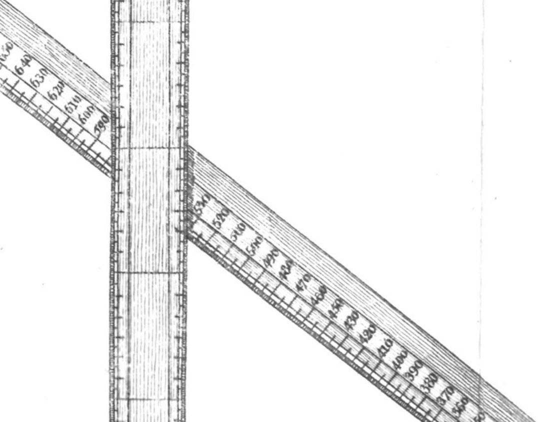

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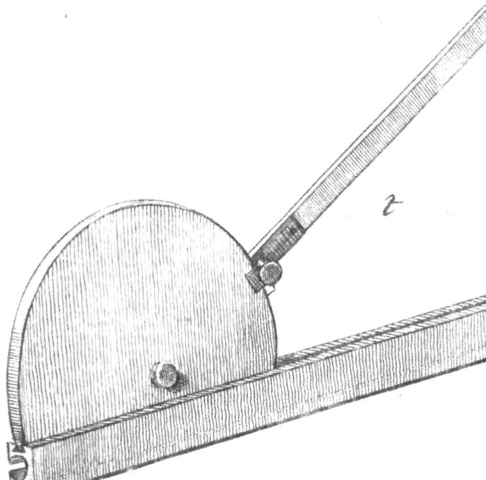

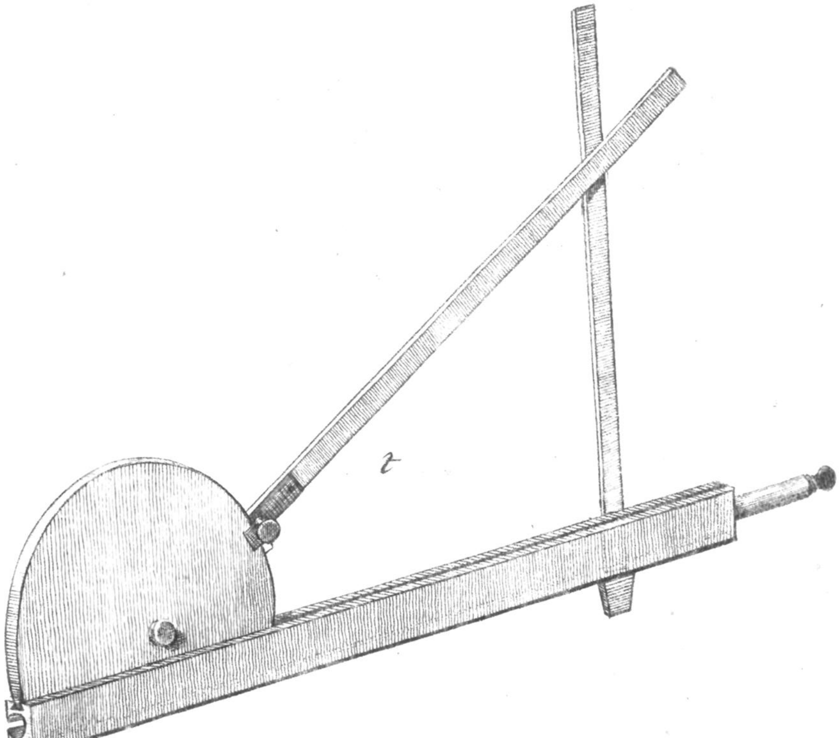
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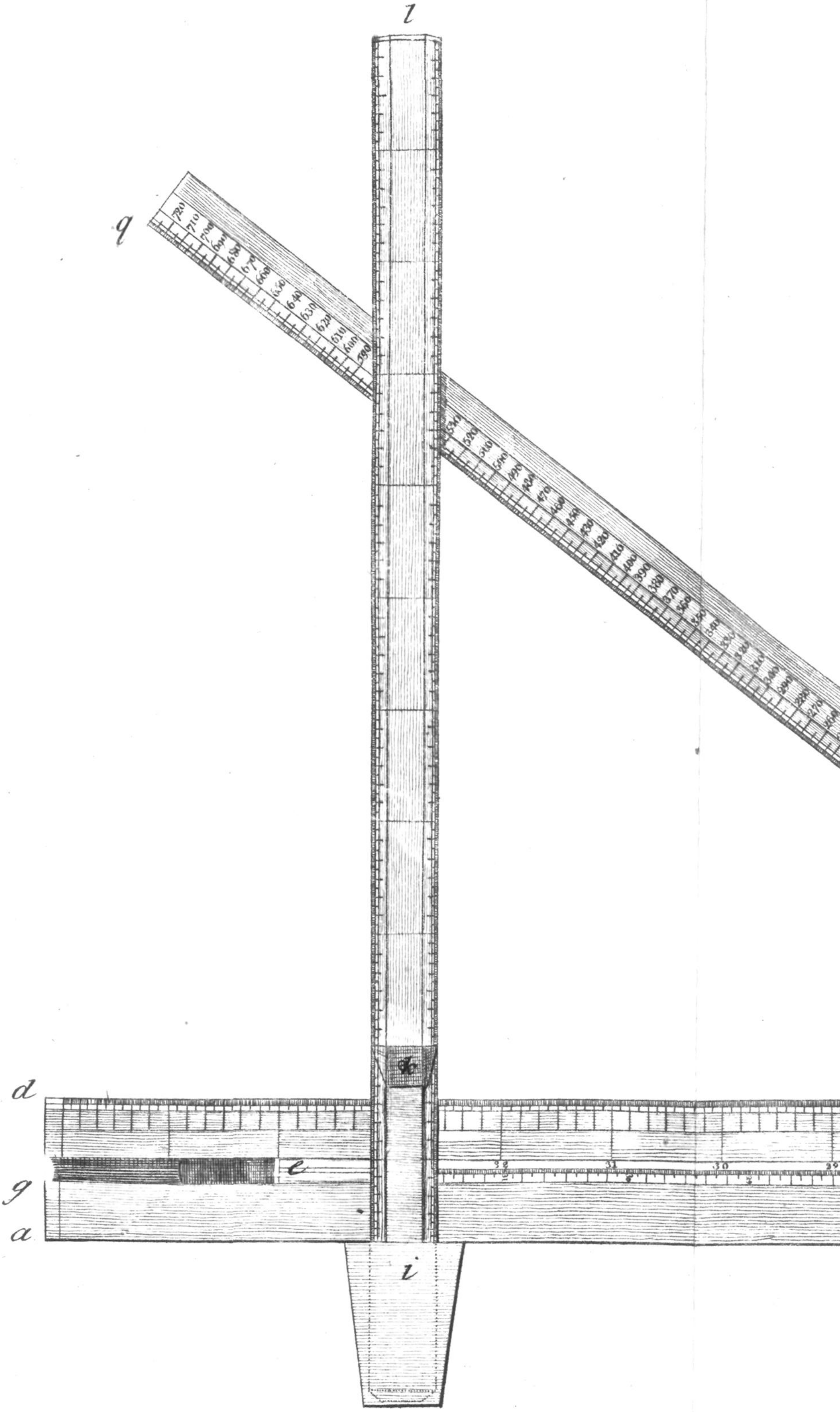
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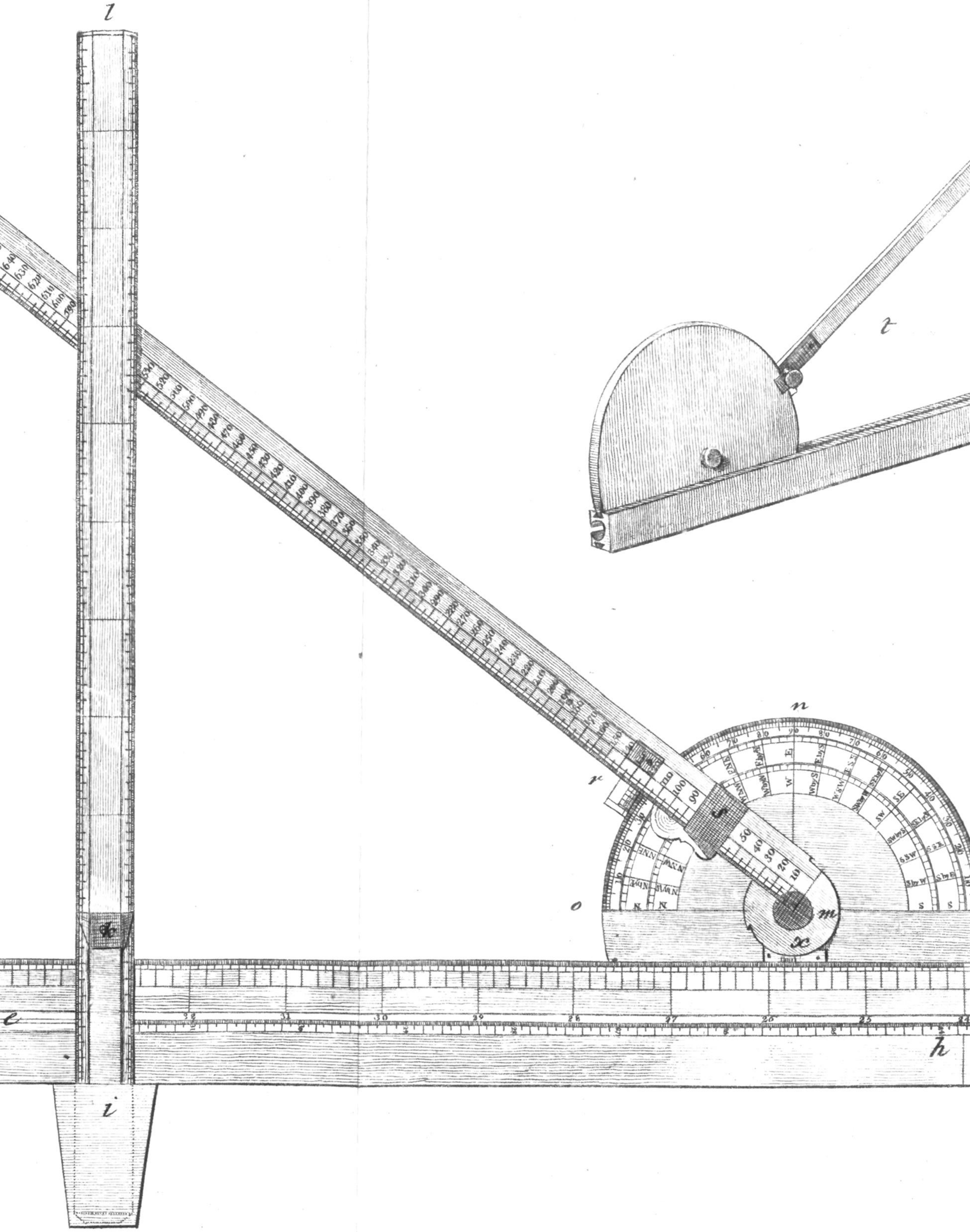
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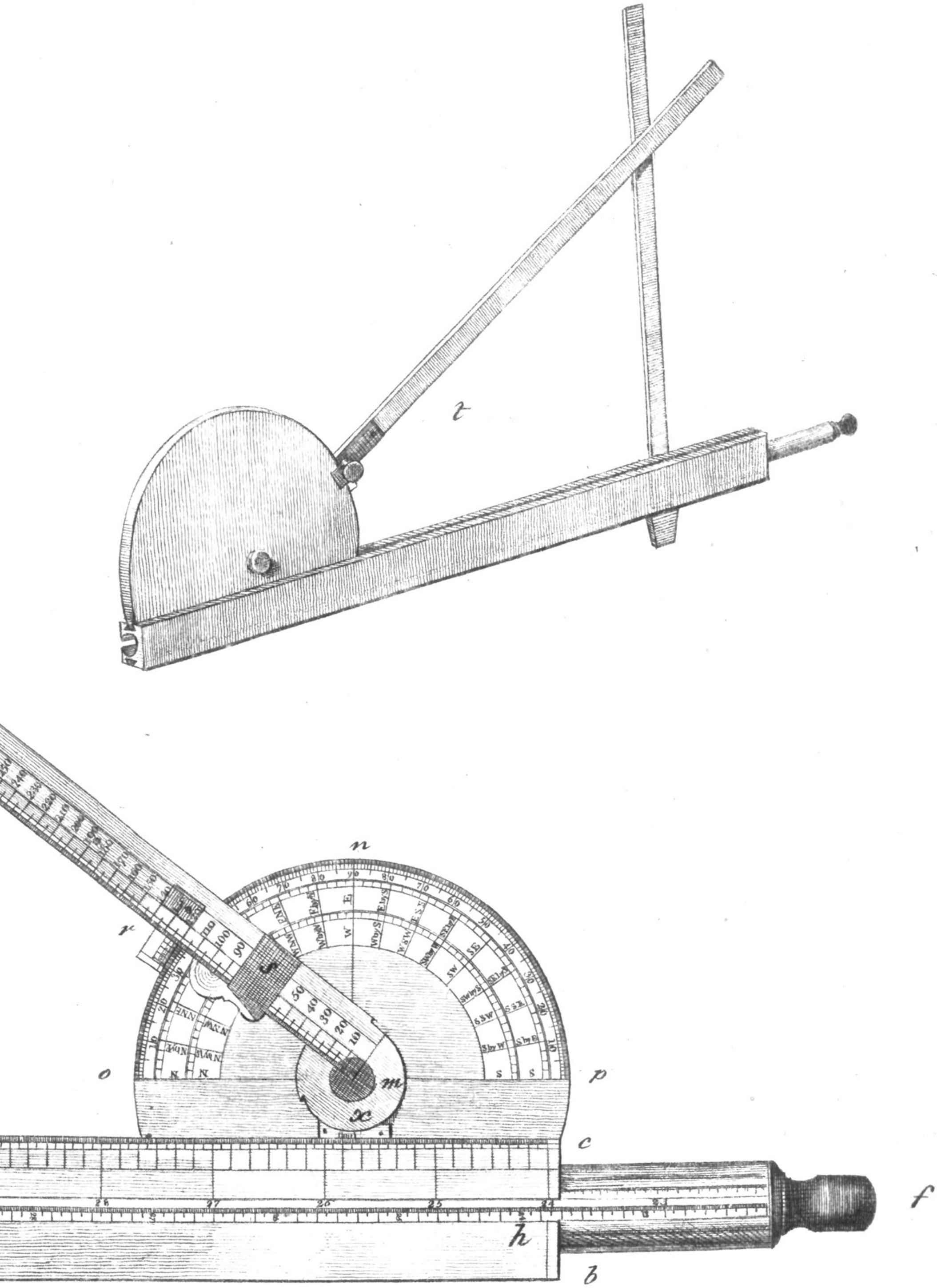

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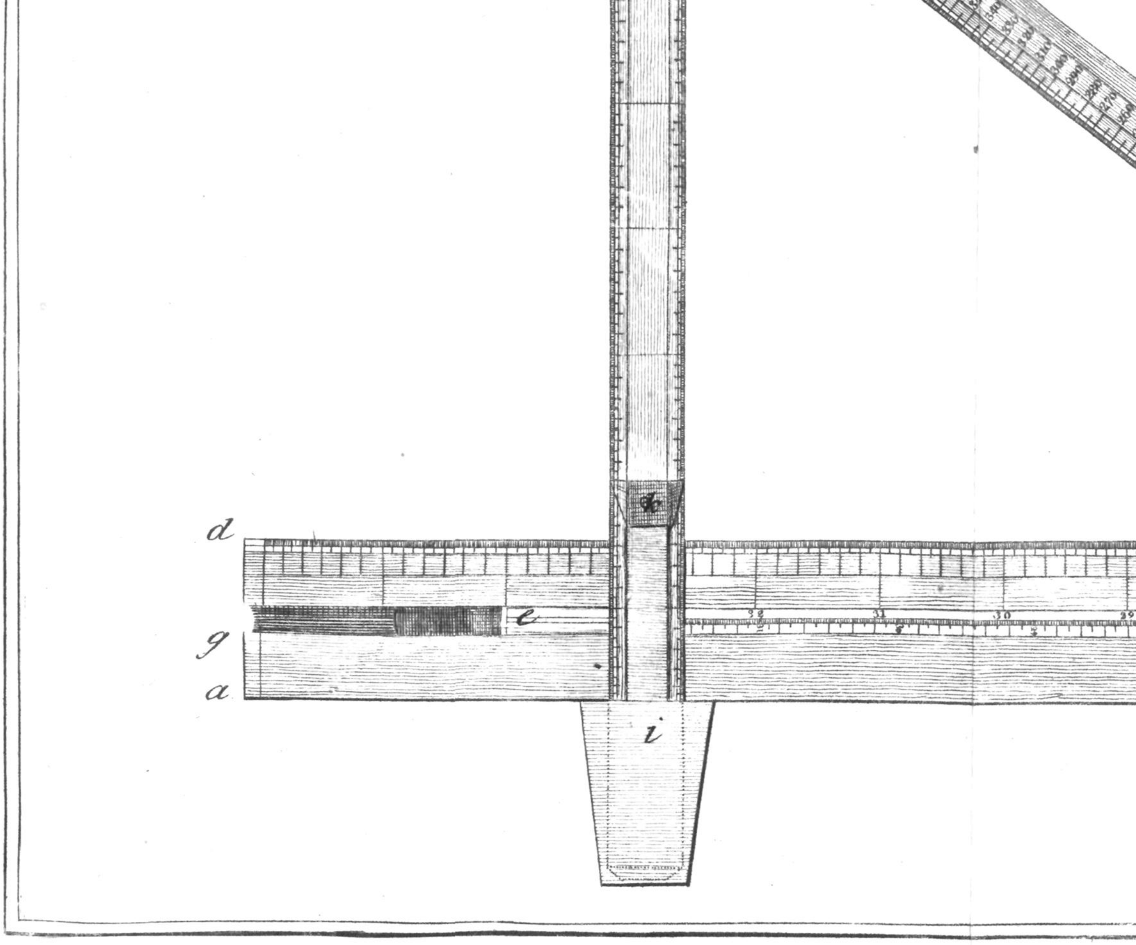
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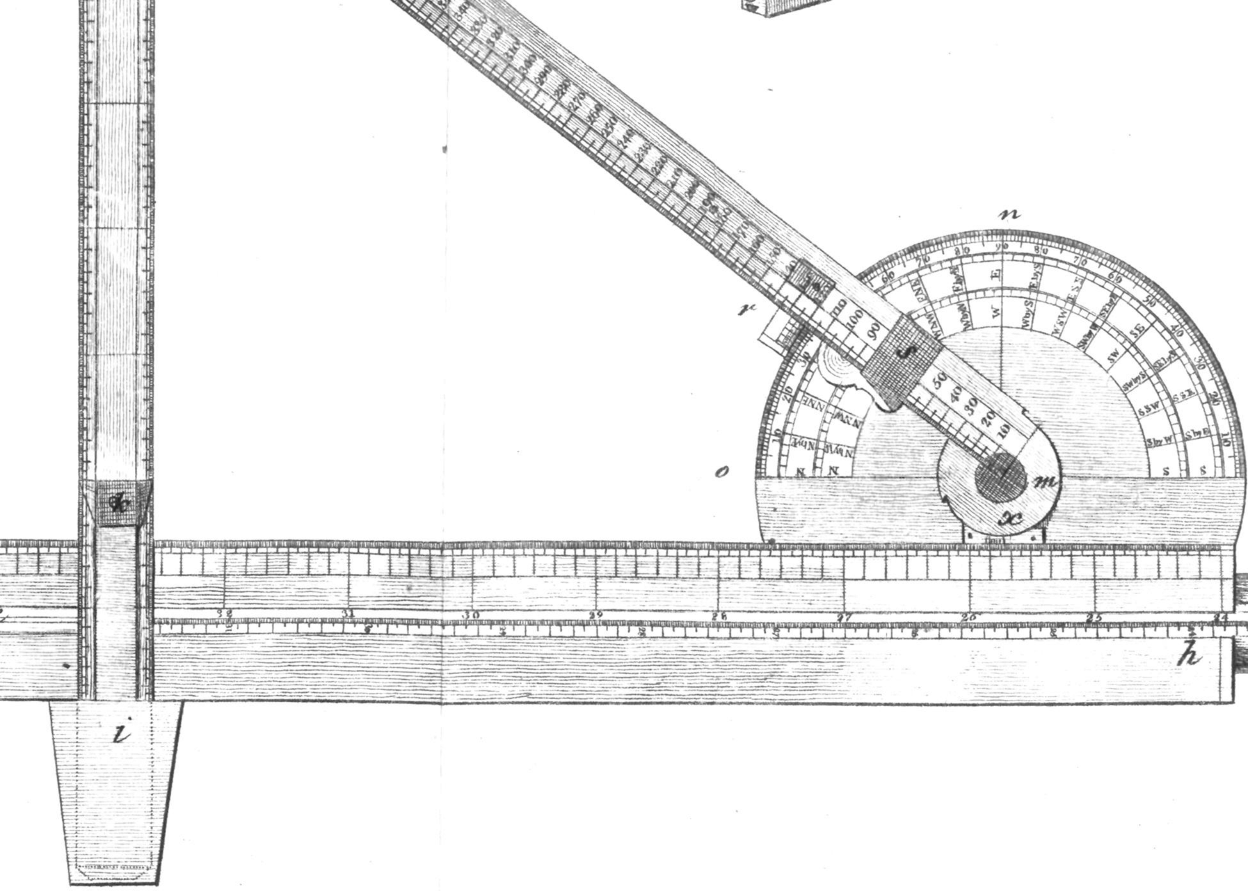
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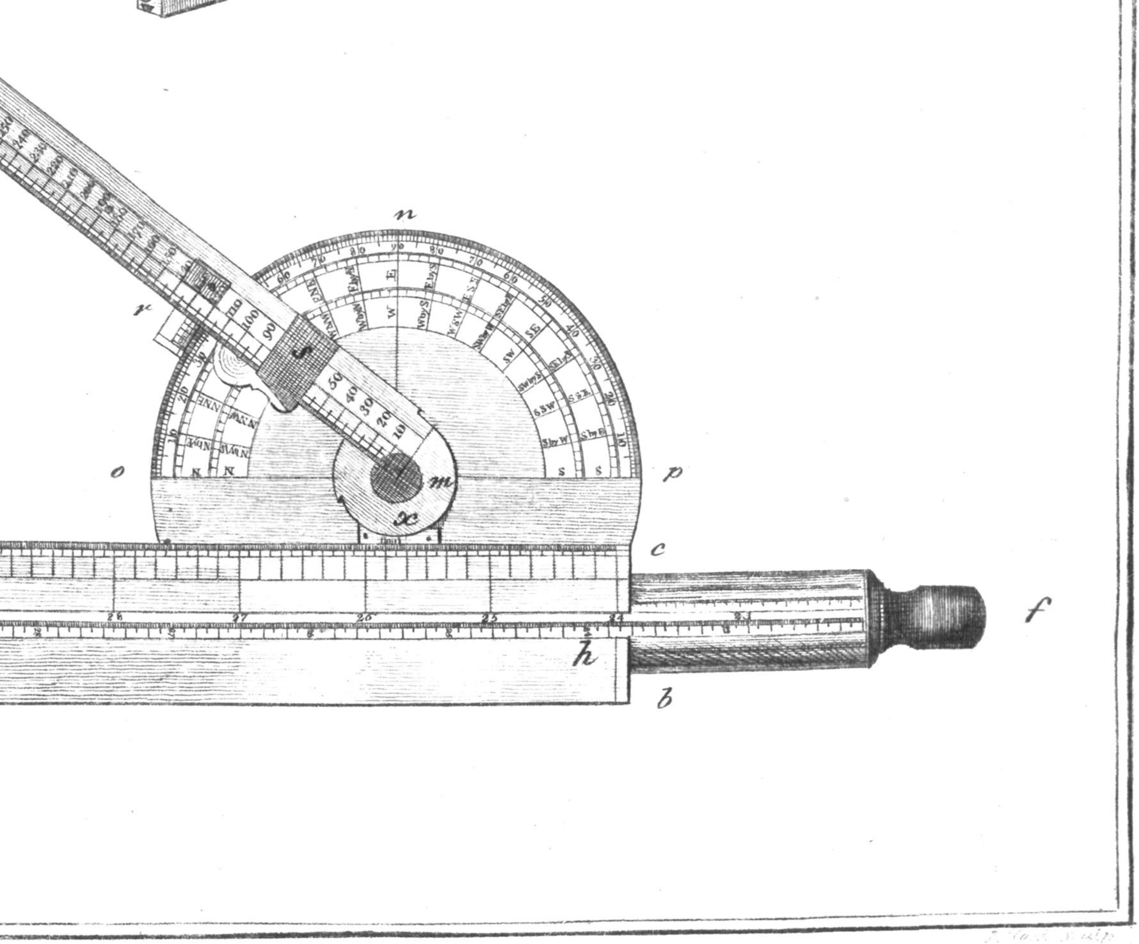
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WbN
WNW
NWbW
NW
NWbN
NNW
NbW
10
20
30
40
50
60
70
80
90
100
110
24
25
26
27
28

J. Roe Sculp